# Space Weather Technical Forecast

Issued on Sunday, 28 July 2024 at 01:19 Local

**This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales**

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**Space Weather Forecast Headline: G1-G2/Minor to Moderate Storms expected into Day 2 and Day 3 (29-30 Jul) given potential CME arrivals. Isolated R1-R2 Radio Blackouts likely throughout.**

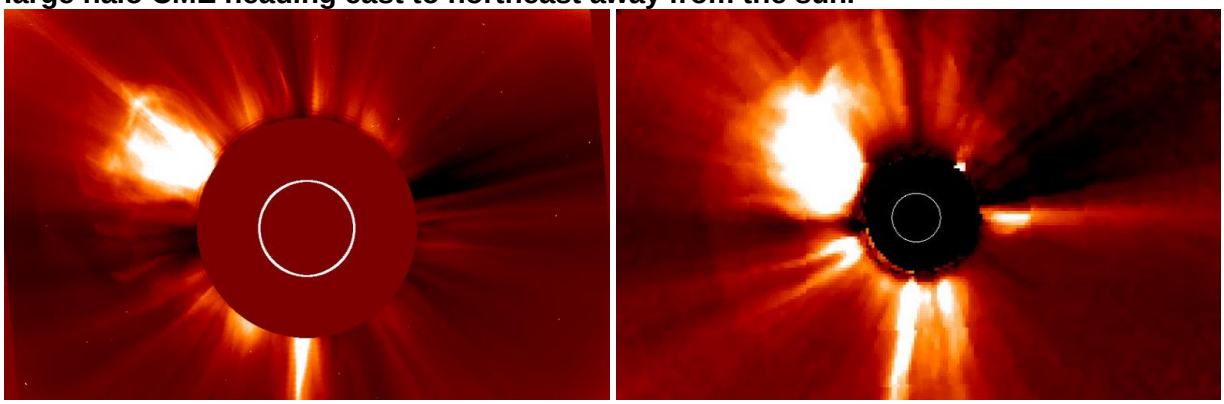
**Analysis of Space Weather Activity over past 24 hours**

**Solar Activity:** Solar activity has been Moderate, with several M-class flare, one of which was an M4.2 peaking at 27/0237 UTC from the cluster of regions located in the southeast, likely near AR3766. The most recent one was an M3.4 observed at 27/1839 UTC from AR3762, this region having contributed to two other M-class flares in the last 24 hours.

There are currently up to ten sunspot regions on the solar disc. AR3762, in the southwest quadrant, remains the largest and most complex region. Its leading portion is showing signs of growth with an agglomeration of spots around a large penumbra but its trailing portion is becoming faint although it continues to exhibit a delta spot. The cluster of sunspot regions transiting across the southeast quadrant continues to grow in size and complexity, with intricate magnetic looping bringing additional instability. All other remaining regions appear small, simple and/or largely unchanged.

A large halo CME was observed on Coronagraph and Stereo imagery around 27/0500 UTC, heading to the east. The source is still unknown but the analysis has at least managed to establish that this CME is most likely far-sided. A partial halo was also subsequently observed shortly after 27/0600 UTC. It may be attributed to AR3762 since dimming was observed at a similar time but the signal is contaminated by the large far-sided event, resulting in a low confidence analysis with an arrival at Earth possible at the end of 29 July or beginning of 30 July.

**Figure 0: Lasco C2 at 27/0512 UTC (left ) and Stereo-A at 27/0553 UTC (right), showing a large halo CME heading east to northeast away from the sun.**



**Solar Wind / Geomagnetic Activity:** Solar winds, as measured by ACE at L1, have steadily declined through the period, from 500 km/s to 400 km/s. Density was well below average. The

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Interplanetary magnetic field, Bt, was mostly weak and between 5-8nT. The north-south component, Bz, was fluctuating between +5nT and -7nT but has become weaker and largely positive after 27/1330 UTC. The phi angle was predominately positive (away from the Sun). Resulting geomagnetic activity was generally Quiet to Unsettled (Kp 1-3), with a provisional Active (Kp4) interval observed between 27/1200-1500 UTC.

**Energetic Particles / Solar Radiation:** High energy (greater than 10 MeV) proton flux observed by GOES18 is at background levels. High energy electron flux (greater than 2MeV) observed at GOES16 was mostly at background levels but became moderate for a short time. The 24-hour fluence was well below Active albeit higher than of late, with 3.43e6 integrated pfu observed at 28/0000UTC.

**Four-Day Space Weather Forecast Summary**

**Solar Activity:** Activity is expected to be Low to Moderate with further M-class flares likely and and slight chance of isolated X-class flares.

**Solar Wind /Geomagnetic Activity:** Current solar wind speeds are thought likely to gradually decline in the absence of CME influence over the next 36 hours, perhaps down to slow-ambient levels. Geomagnetic activity is therefore expected to be generally Quiet to Unsettled at first but to increase to G1-G2 Minor to Moderate storm conditions at the end of Day 2 and into Day 3 (29-30 July), with a slight chance of G3 Strong Storm given the potential for the aforementioned CME arrival.

**Energetic Particles / Solar Radiation:** High energy proton flux is most likely to remain at background levels. However, there is a slight chance of exceeding the S1/Minor Storm threshold should any notable flares occur, most likely from AR3762 in the near term.
The high energy electron flux is most likely to stay at background levels but may show an increasing trend on Day 3 and Day 4. The associated 24-hour fluence is most likely to remain below the Active threshold (1e8 integrated pfu) but with a potential rising trend during the period.

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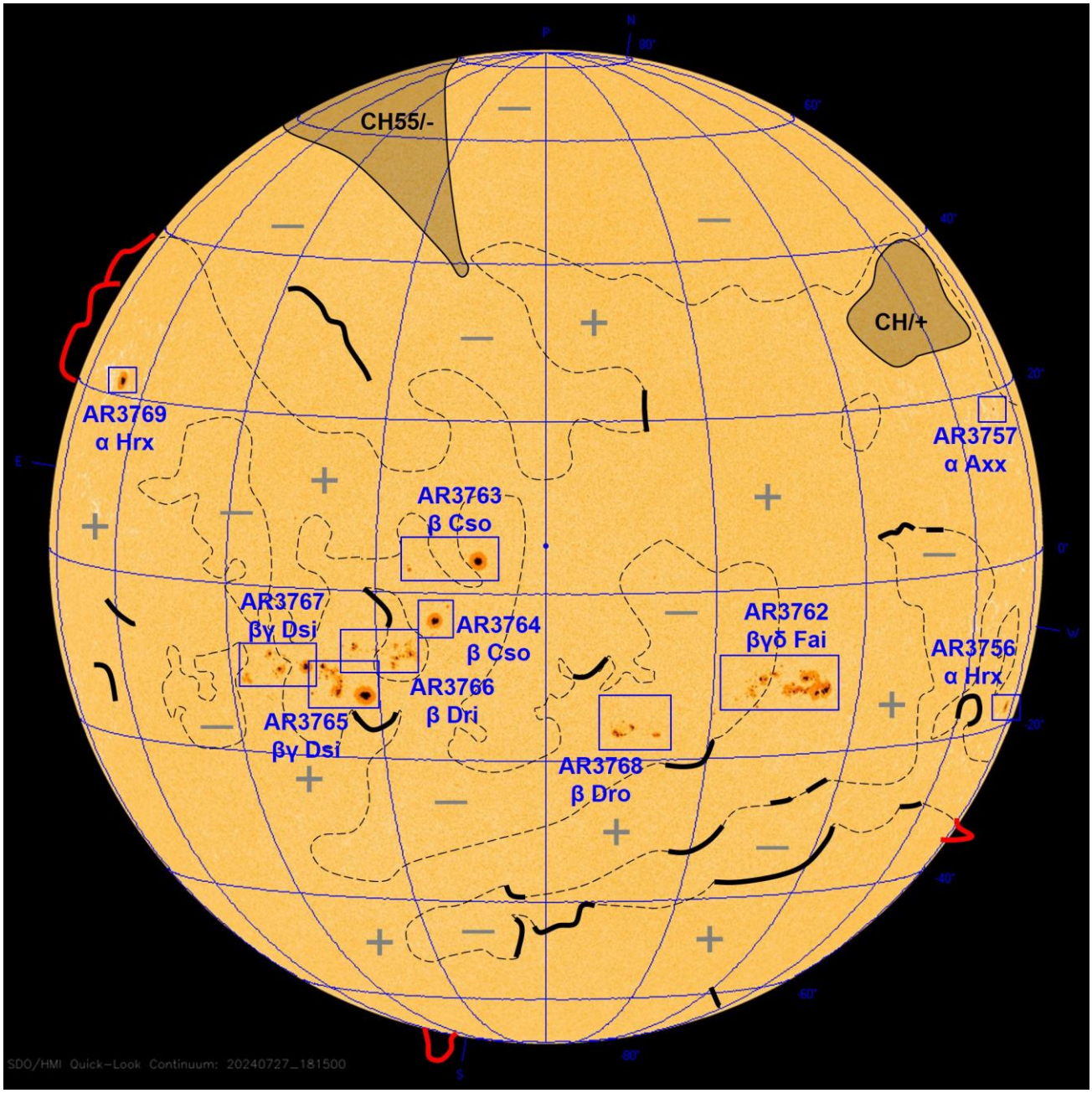
**Figure 1. Solar Analysis Valid 27/2000 UTC.**




**Key:** Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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# Met Office Space Weather Technical Forecast

## Geomagnetic Storms:

No Coronal hole HSS feature in this forecast. A filament lift-off and associated CME from the southern centre disk were observed in coronagraph imagery late on the 26th. This feature was analysed as Earth directed, with an arrival into Day 3 (30 Jul). However, the CME that was observed leaving the sun shortly after 27/0600 UTC has been analysed as potentially Earth-directed too. This CME is estimated to travel at a faster velocity and to catch up the first one before it reaches Earth, sometime at the end of Day 2 or beginning of Day 3 (29/30 July). Confidence is however low.

Current solar wind speeds are thought likely to gradually decline in the absence of CME influence over the next 36 hours, perhaps down to slow-background levels. Geomagnetic activity is therefore expected to be generally Quiet to Unsettled at first but to increase to G1-G2 Minor to Moderate storm conditions at the end of Day 2 and into Day 3 (29/30 July), with a slight chance of G3 Strong Storm given the potential for the aforementioned CME arrival.

| Geo-Magnetic Storm Probability (Exceedance) | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| Minor or Moderate | G1 to G2 | No | 1 | 60 | 60 | 10 |
| Strong | G3 | No | 1 | 20 | 15 | 1 |
| Severe | G4 | No | 1 | 5 | 5 | 1 |
| Extreme | G5 | No | 1 | 1 | 1 | 1 |

## Geomagnetic Activity - Earthbound Coronal Mass Ejections

| Date/time 21.5R (UTC) | Halo: Full or Partial | Source | Source Location | Estimated Speed | Estimated Arrival Time | Comments |
|---|---|---|---|---|---|---|
| 27/1100 | Full | M3.1 flare | AR3762 | 740 km/s | 30/0200 UTC +/- 6hrs | Low confidence |

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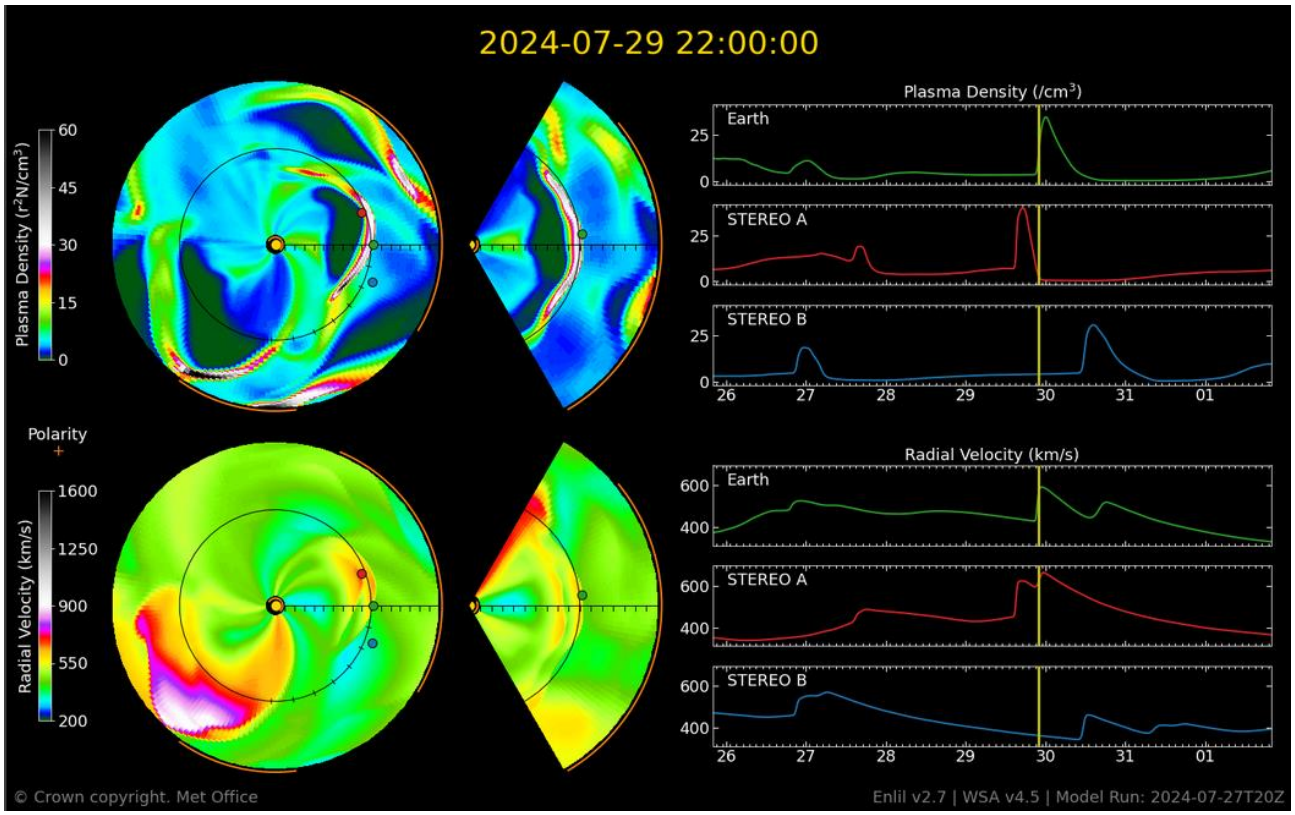
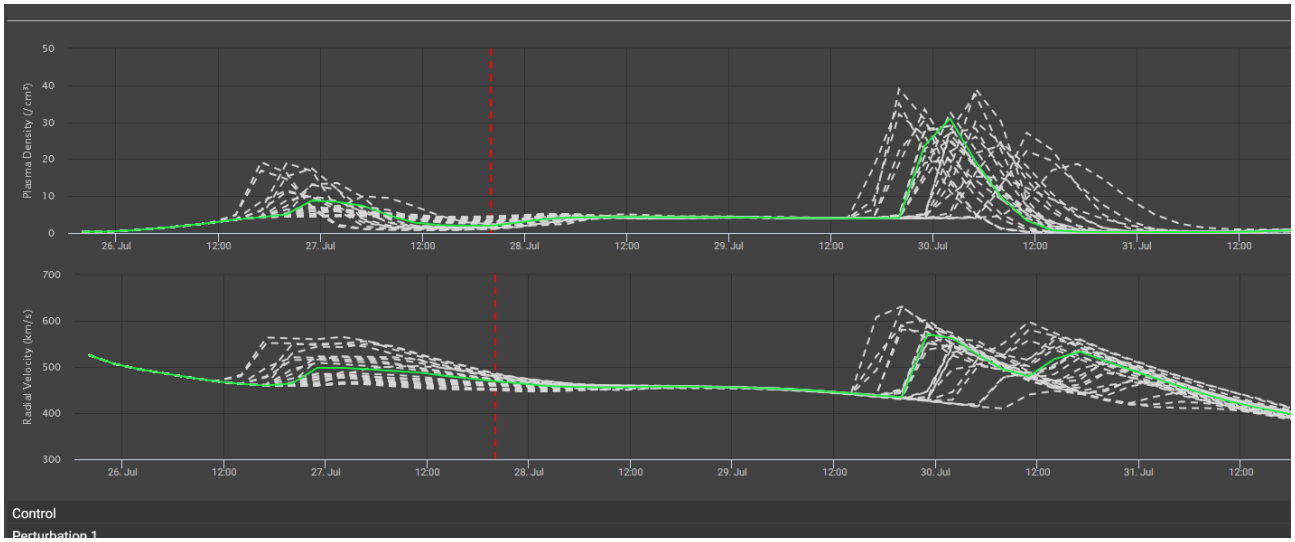
**Figure 2: MOSWOC Enlil and Ensemble showing a potential CME arrival either late on 29 or early on 30 July.**





Plasma Density (/ cm³)
Radial Velocity (km/s)
26. Jul 12:00 27. Jul 12:00 28. Jul 12:00 29. Jul 12:00 30. Jul 12:00 31. Jul 12:00
Control
Perturbation 1

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**Radio Blackouts - X-Ray Flares:**
There are currently up to ten sunspot regions on the solar disc. AR3762, in the southwest quadrant, remains the largest and most complex region. Its leading portion is showing signs of growth with an agglomeration of spots around a large penumbra but its trailing portion is becoming faint although it continues to exhibit a delta spot. The cluster of sunspot regions transiting across the southeast quadrant continues to grow in size and complexity, with intricate magnetic looping bringing additional instability. All other remaining regions appear small, simple and/or largely unchanged.

Overall activity is expected to be Low to Moderate with further M-class flares likely and and slight chance of isolated X-class flares.

| X Ray Flares<br>Probability | Level | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **R1-R2 M Class** | Yes | 60 | 60 | 60 | 60 |
| **Very Active** | **R3 to R5 X Class** | No | 10 | 10 | 10 | 10 |

**Figure 3: Latest X-Ray flare activity, as observed by GOES-18**

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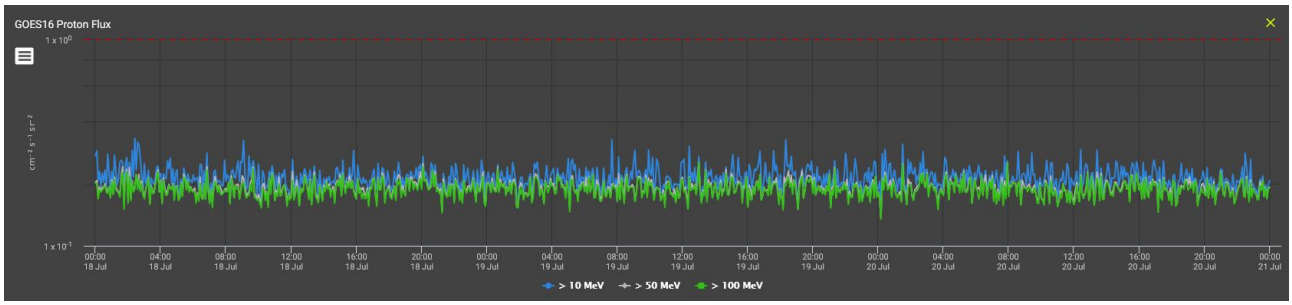
**Solar Radiation Storms - (High Energy Protons):**
High energy protons are currently at background levels. Proton flux is most likely to remain at background levels, although there is a slight chance of reaching the S1/minor radiation storm threshold, should any notable flare occur. The best candidate is currently AR3762 given its location on the visible disc, the risk considered to increase slightly on Day 3 and Day 4 (30-31 July) when the cluster of active regions is expected to arrive into the southwest quadrant.

| Radiation Storms Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $s^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC) (%) | Day 2 (00-24 UTC) (%) | Day 3 (00-24 UTC) (%) | Day 4 (00-24 UTC) (%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ S1** | No | 10 | 10 | 15 | 15 |
| **Very Active** | **≥ S3 *** | No | 1 | 1 | 1 | 1 |
| * S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$) | | | | | | |

**Figure 4: Latest Proton Flux, as observed by GOES-16**

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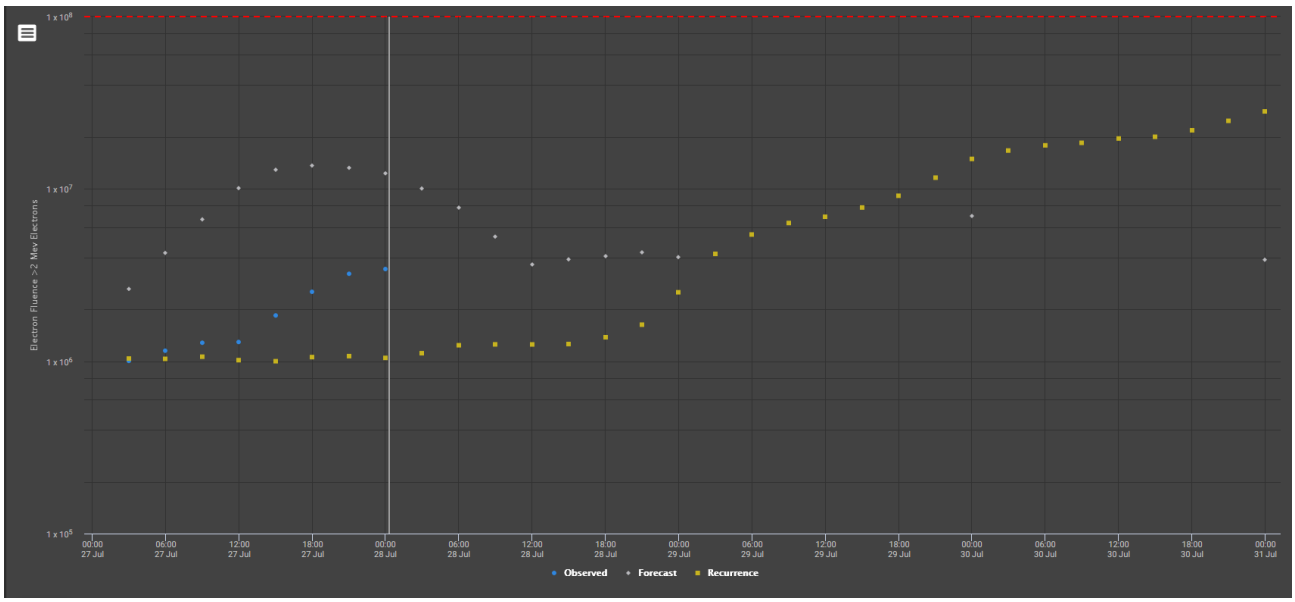
**High Energy Electrons Event (≥ 2MeV):**
High energy electron flux, as observed by GOES-16, is expected to remain at background levels for the start of the period. The recent CME and potential fast wind enhancement may have caused an increase in electron flux below GEO, but the potential for further CME arrivals into the period could suppress this once again. Overall, electron flux is most likely to stay at background levels, but as the solar wind speeds decline there is the possibility of an increase to peak at moderate or perhaps high levels at times.

The associated electron fluence is most likely to persist below the Active threshold (1e8 integrated pfu), but with the potential for a rising trend during the period. The latest MOSWOC REFM output is forecasting a rising trend below Active, which is viewed as generally good guidance though with lower than usual confidence given the potential for further CME influence.

| GEO Electron Environment<br>Probability (Exceedance) | Level ($cm^{-2}$ $sr^{-1}$ $day^{-1}$) | Past 24 Hours (Yes/No) | Day 1 (00-24 UTC)<br>(%) | Day 2 (00-24 UTC)<br>(%) | Day 3 (00-24 UTC)<br>(%) | Day 4 (00-24 UTC)<br>(%) |
|---|---|---|---|---|---|---|
| **Active** | **≥ 2 MeV ≥ $1x10^8$** | No | 1 | 5 | 10 | 20 |
| **Very Active** | **≥ 2 MeV ≥ $1x10^9$** | No | 1 | 1 | 1 | 1 |

**Figure 5: Latest MOSWOC REFM output**

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